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Viscosity Properties and Molecular Structure of Lube Base Oil Prepared from Fischer-Tropsch Waxes

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Lube base oils were prepared by hydrocracking/isomerization of Fischer-Tropsch synthesized waxes and long-chain α-olefins with various carbon chain lengths. Correlations between operation conditions, viscosity properties of base oil, and molecular structures were investigated. Prepared base oils showed very high viscosity indexes of up to 159, but these varied widely with the severity of the hydrocracking/isomerization conditions and feedstock. Viscosity indexes of base oil had a good correlation with the severity of the hydrocracking/isomerization conditions, that is higher conversion resulted in lower viscosity index. "Average branching numbers" were calculated from the average carbon numbers and the ratio of CH, CH_3 carbons obtained from ^{13}C-NMR analysis, considering that the base oils mainly consisted of noncyclic paraffins. Increased conversion resulted in decreased average carbon number and increased average branching number with all feedstocks. Even with conversion of under 10%, about 2 branches per molecule were generated. On the other hand, the rate of generation of 3 or more branches was comparatively low. Average carbon number and average branching number also showed good correlations with the viscosity properties of the base oil such as kinematic viscosity and viscosity index. Viscosity indexes increased with higher average carbon number or lower average branching number. The effect of average carbon number or average branching number on the viscosity index depended on the feedstock, so a new index (average carbon number)^2 × (average branching number)$^{-1}$ was introduced as a molecular structural parameter of paraffins, and the index was confirmed to indicate the viscosity index regardless of the feedstock. A

similar structural parameter (average carbon number)^a × (average branching number)^b was applied to kinematic viscosity. Kinematic viscosities at 40°C and 100°C showed good correlations when $(a, b) = (3.5, 0.9)$ and $(3.0, 0.5)$, respectively.

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